



Hydraulic Cylinders Precautions 1

Be sure to read before handling.

Design

⚠ Warning

1. **There is a possibility of dangerous sudden action by cylinders if sliding parts of machinery are twisted due to external forces, etc.**

In such cases, human injury may occur; e.g., by catching hands or feet get caught in the machinery, or damage to the machinery itself may occur. Therefore, the machine should be designed to prevent such dangers.

2. **A protective cover is recommended to minimize the risk of personal injury.**

If a stationary object and moving parts of a cylinder are in close proximity, personal injury may occur. Design the structure to avoid contact with the human body.

3. **Securely tighten all stationary parts and connected parts so that they will not become loose.**

Especially when a cylinder operates with high frequency or is installed where there is a lot of vibration, ensure that all parts remain secure.

4. **Cases when a deceleration circuit or shock absorber may be required.**

When a driven object is operated at high speed or the load is heavy, a cylinder's cushion will most likely not be sufficient to absorb the impact. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the impact.

In this case, the rigidity of the machinery should also be examined.

5. **Consider a possible drop in operating pressure due to a power outage.**

When a cylinder is used as a clamping mechanism, there is a danger of work pieces dropping if there is a decrease in clamping force due to a drop in circuit pressure caused by a power outage. Therefore, safety equipment should be installed to prevent human injury or damage to machinery. Suspension mechanisms and lifting devices also require for drop prevention measures.

6. **Consider a possible loss of power source.**

Measures should be taken to protect against human injury and equipment damage in the event that there is a loss of power to equipment controlled by air pressure, electricity, or hydraulics.

7. **Design the circuitry to prevent sudden lurching of driven objects.**

When hydraulic pressure in a cylinder is zero, the driven object will lurch at high speed if pressure is applied to one side of the piston. Therefore, equipment should be selected and circuits designed to prevent sudden lurching because there is a danger of human injury and/or damage to equipment when this occurs.

8. **Consider emergency stops.**

Design the system so that bodily injury and/or damage to machinery and equipment will not occur when machinery is stopped by a manual emergency stop or a safety device triggered by abnormal conditions.

9. **Consider the action when operation is restarted after an emergency or abnormal stop.**

Design machinery so that bodily injury or equipment damage will not occur upon restart of operation. When the cylinder has to be reset at the starting position, install manual safety equipment.

Selection

⚠ Warning

1. **Confirm the specifications.**

The products featured in this catalog are designed strictly for use in industrial oil hydraulic system applications. If the products are used in conditions that are outside the range of pressure and temperature specifications, damage and/or malfunction may occur. Do not use in these conditions. (Refer to the specifications.)

Please consult with SMC if a fluid other than hydraulic fluid is to be used.

2. **Intermediate stops**

Since hydraulic cylinders are not guaranteed for zero oil leakage, it may not be possible to hold a stopped position for an extended period of time.

3. **Take surge pressure into consideration.**

Use cylinders which can withstand the surge pressures (maximum allowable pressure) generated in hydraulic systems. (Refer to specifications.)

Inside cylinders, pressure may be generated that is higher than the set pressure for the relief valve, e.g., internal pressure due to load inertia or surge pressure when switching valves. Consider these factors and determine the operating pressure so that the pressure generated inside cylinders will be within the maximum allowable pressure.

Pressure terminology used in this catalog is defined as follows:

Nominal pressure	Pressure assigned to a cylinder for convenient identification. It is not necessarily the same as the operating pressure which guarantees performance under specified conditions.
Maximum allowable pressure	The maximum allowable value for the pressure that is generated inside cylinders (such as surge pressure).
Proof pressure	Test pressure that the cylinder must be able to withstand without lowering system performance when returning to the nominal pressure.
Minimum operating pressure	Minimum pressure at which a horizontally installed cylinder operates with no-load.

4. **Take into account compatibility with hydraulic fluids.**

Hydraulic fluid	Compatibility
Standard mineral hydraulic fluid	○
W/O hydraulic fluid	○
O/W hydraulic fluid	○
Water-Glycol hydraulic fluid	*
Phosphate hydraulic fluid	×

* Please consult with SMC.

⚠ Caution

1. **Use the product within the limits of the maximum usable stroke.**

The piston rod will be damaged if operated beyond the maximum stroke. Refer to the Hydraulic Cylinder Stroke Selection (pages 147 to 154) for maximum strokes.



Hydraulic Cylinders Precautions 2

Be sure to read before handling.

Selection

⚠ Caution

1. **Operate the piston within a range such that collision damage will not occur at the stroke end.**

Operate within a range such that damage will not occur when the piston having inertial force stops by striking the cover at the stroke end.

- (1) Take load factors and piston speed (page 143) into consideration and determine the operability by referring to the chart under "Selection Standards".
- (2) When using a cylinder with no cushion, the speed when the piston strikes the cover should be reduced to 50 mm/sec or lower (a level at which no metallic sound is generated), or a stopper should be installed on the outside.

2. **Use a flow control valve to adjust the hydraulic cylinder drive speed, gradually increasing from a low speed to the desired speed setting.**

3. **Provide intermediate supports for long stroke cylinders.**

Provide intermediate supports for cylinders with long strokes to prevent piston rod damage due to sagging of the piston rod, deflection of the tube, vibration, and external loads.

Mounting

⚠ Caution

1. **Be certain to align the axis center of the piston with the load and direction of movement when connecting.**

When not properly aligned, twisting of the piston rod and tubing may occur, and damage may be caused due to wear on areas such as the inner tube surface, bushings, piston rod surface and seals.

2. **When an external guide is used, connect the piston rod end and the load in such a way that there is no interference at any point within the stroke.**

3. **Do not scratch or gouge the sliding parts of the cylinder tube by striking or grasping it with other objects.**

Cylinder bores are manufactured to precise tolerances so that even a slight deformation may cause faulty operation.

4. **Do not use until you verify that the equipment can operate properly.**

Following mounting, repairs, or conversions, verify correct mounting by conducting suitable function and leakage tests after piping and power connections have been made.

5. **Operation manual**

The product should be mounted and operated after the operation manual is thoroughly read and its contents are understood.

Keep the operation manual where it can be referred to as necessary.

Piping

⚠ Caution

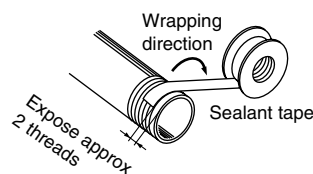
1. **Preparation before piping**

Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove chips, cutting oil and other debris from inside the pipe.

2. **Wrapping of pipe tape**

When screwing together pipes and fittings, be certain that chips from the pipe threads and sealing material do not get inside the piping.

Also, when sealant tape is used, leave 1.5 to 2 thread ridges exposed at the end of the pipe.



3. **Set up so that air cannot accumulate inside piping.**

Cushion

⚠ Caution

1. **Readjust using the cushion needle.**

Cushion needles are adjusted at the time of shipment. When the cylinder is put into service, the cushion needles should be readjusted based on factors such as the size of the load and the operating speed. When the cushion needles are turned clockwise, restriction of the air flow becomes greater and thus the cushioning effect also increases.

2. **Do not operate with the cushion needle in a fully closed condition.**

This will contribute to the generation of surge pressure, and the cylinder or equipment can be damaged.

3. **Do not overly loosen the cushion needle.**

This may cause oil to flow out. (As a guideline, loosen the needle 2 turns or less from the fully closed position).

Air Release

⚠ Caution

1. **Operate after opening the air release valve and completely releasing any internal air.**

Residual air can cause malfunction.

2. **When adjusting the air release, do not loosen the plug too much.**

Use caution, since loosening the plug too much may cause it to fly out or fluid to blow out, posing a danger of human injury.

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Related
Equipment

D-☐



Hydraulic Cylinders

Precautions 3

Be sure to read before handling.

Hydraulic Fluid

Warning

1. Use clean fluid.

Do not use deteriorated fluid or fluid containing foreign matter, moisture or corrosive additives, as this can cause the malfunction and damage or corrosion of parts.

Caution

1. Install hydraulic fluid filters.

Provide your hydraulic system with hydraulic fluid filters with a filtration degree of 10 μm or finer.
Refer to the SMC's hydraulic filter specifications.

2. Use the product within the specified range of fluid and ambient temperature.

Take measures to prevent freezing, since moisture in hydraulic fluid will freeze at 0°C or below, and this may cause damage to seals and lead to malfunction.

3. Use hydraulic fluid with a viscosity grade equivalent to ISO VG32 or VG46.

Operating Environment

Warning

1. Do not use in an environment where there is a danger of corrosion.

Refer to each construction drawing on the cylinders material.

2. Install a protective cover if the product is to be used in a dusty environment or where it will be exposed to chips and spatter.

When water droplets or coolant are spattering, use a water resistant hydraulic cylinder.

Maintenance

Warning

1. Perform maintenance inspection according to the procedures indicated in the operation manual.

If handled improperly, malfunction and damage of machinery or equipment may occur.

2. Removal of equipment

When machinery is removed, first ensure that there are measures in place to prevent the fall or sudden, erratic movement of driven objects and equipment. Then, cut off the air supply and electric power, and reduce the pressure in the system to zero. When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent cylinders from sudden movement.

Caution

1. Perform periodic maintenance on filters installed in a hydraulic system in order to keep the oil clean.

If the oil used in hydraulic cylinders contains foreign matter, parts such as the piston seals and rod seals will be damaged.



Auto Switches Precautions 1

Be sure to read before handling.

Design / Selection

Warning

1. Confirm the specifications.

Read the specifications carefully and use this product appropriately. The product may be damaged or malfunction if it is used outside the specification range for current load, voltage, temperature or impact.

We do not guarantee against any damage if the product is used outside of the specification range.

2. Cautions for use in an interlock circuit

When an auto switch is used for an interlock signal requiring high reliability, devise a double interlock system to avoid trouble by providing a mechanical protection function, or by also using another switch (sensor) together with the auto switch. Also, perform periodic maintenance and confirm proper operation.

3. Do not make any modifications (including exchanging the printed circuit boards) to the product.

It may cause human injuries and accidents.

Caution

1. Pay attention to the length of time that a switch is ON at an intermediate stroke position.

When an auto switch is placed at an intermediate position of the stroke and a load is driven at the time the piston passes, the auto switch will operate, but if the speed is too great the operating time will be shortened and the load may not operate properly. The maximum detectable piston speed is:

$$V \text{ (mm/s)} = \frac{\text{Auto switch operating range (mm)}}{\text{Time load applied (ms)}} \times 1000$$

In cases of high piston speed, the use of an auto switch (D-F5NTL, F7NTL, G5NTL, M5NTL, M5PTL) with a built-in OFF delay timer (approx. 200 ms) makes it possible to extend the load operating time.

The wide-range detection type D-G5NBL (operating range 35 to 50 mm) may also be useful, depending on the application. Please consult with SMC for other models.

Caution

2. Keep wiring as short as possible.

<Reed>

As the length of the wiring to a load gets longer, the rush current at switching ON becomes greater, and this may shorten the product's life. (The switch will stay ON all the time.)

- 1) Use a contact protection box when the wire length is 5 m or longer.
- 2) Even if an auto switch has a built-in contact protection circuit, when the wiring is more than 30 m long, it is not able to adequately absorb the rush current and its life may be reduced. It is again necessary to connect a contact protection box in order to extend its life. Please consult with SMC in this case.

<Solid state>

- 3) Although wire length should not affect switch function, use a wire 100 m or shorter.

If the wiring is longer it will likely increase noise although the length is less than 100 m.

When the wire length is long, we recommend the ferrite core is attached to the both ends of the cable to prevent excess noise.

A contact protection box is not necessary for solid state switches due to the nature of this product construction.

3. Do not use a load that generates surge voltage. If a surge voltage is generated, the discharge occurs at the contact, possibly resulting in the shortening of product life.

If driving a load such as a relay that generates a surge voltage,

<Reed>

Use an auto switch with built-in contact protection circuit or use a contact protection box.

<Solid state>

Use a built-in surge absorbing element type device.

4. Take precautions when multiple cylinders/actuators are used close together.

When multiple auto switch cylinders/actuators are used in close proximity, magnetic field interference may cause the auto switches to malfunction. Maintain a minimum cylinder separation of 40 mm. (When the allowable interval is specified for each cylinder series, use the indicated value.)

The auto switches may malfunction due to the interference from the magnetic fields.

Use of a magnetic screen plate (MU-S025) or commercially available magnetic screen tape can reduce the interference of magnetic force.

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Related Equipment

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Auto Switches Precautions 2

Be sure to read before handling.

Design / Selection

Caution

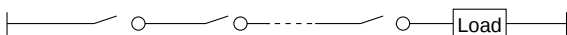
5. Pay attention to the internal voltage drop of the auto switch.

<Reed>

- 1) Auto switch with an indicator light (Except D-A56, A76H, A96, A96V, C76, E76A, Z76)

- If auto switches are connected in series as shown below, take note that there will be a large voltage drop because of internal resistance in the light emitting diodes. (Refer to the internal voltage drop in the auto switch specifications.) [The voltage drop will be “n” times larger when “n” auto switches are connected.]

Even though an auto switch operates normally, the load may not operate.



- In the same way, when operating under a specified voltage, although an auto switch may operate normally, the load may not operate. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

$$\text{Supply voltage} - \text{Internal voltage drop of auto switch} > \text{Minimum operating voltage of load}$$

- 2) If the internal resistance of a light emitting diode causes a problem, select an auto switch without an indicator light (D-A6□, A80, A80H, A90, A90V, C80, R80, 90, E80A, Z80).

<Solid state/2-wire type>

- 3) Generally, the internal voltage drop will be greater with a 2-wire solid state auto switch than with a reed auto switch. Take the same precautions as in 1).

Also, take note that a 12 VDC relay is not applicable.

6. Pay attention to leakage current.

<Solid state/2-wire type>

Current (leakage current) flows to the load to operate the internal circuit even when in the OFF state.

$$\text{Operating current of load (OFF condition)} > \text{Leakage current}$$

If the criteria given in the above formula are not met, it will not reset correctly (stays ON). Use a 3-wire switch if this specification will not be satisfied.

Moreover, leakage current flow to the load will be “n” times larger when “n” auto switches are connected in parallel.

7. Ensure sufficient clearance for maintenance activities.

When designing an application, be certain to allow sufficient clearance for maintenance.

8. When multiple auto switches are required.

“n” indicates the number of auto switches which can be physically mounted on the cylinders/actuators. Detection intervals depends on the auto switch mounting structure and set position, therefore some required interval and set positions may not be available.

9. Limitations of detectable positioning

When using certain mounting brackets, the surface and position where an auto switch can be mounted maybe restricted due to physical interference. For example, when using some bracket types the auto switch cannot be surface mounted at the bottom side of foot bracket, etc.

Select the set position of the auto switch so that it does not interfere with the mounting bracket of the cylinders/actuators (such as trunnion or reinforcement ring).

10. Use the cylinder and auto switch in proper combination.

The auto switch is pre-adjusted to activate properly for an auto-switch-capable SMC cylinder/actuator.

If the auto switch is mounted improperly, used for another brand of cylinders/actuators or used after the alternation of the machine installation, the auto switch may not activate properly.



Auto Switches Precautions 3

Be sure to read before handling.

Mounting / Adjustment

Caution

1. Do not drop or bump.

Do not drop, bump or apply excessive impacts (300 m/s² or more for reed auto switches and 1000 m/s² or more for solid state auto switches) while handling. Although the body of the auto switch may not be damaged, the inside of the auto switch could be damaged and cause malfunction.

2. Observe the proper tightening torque for mounting an auto switch.

When an auto switch is tightened beyond the range of tightening torque, auto switch mounting screws, auto switch mounting brackets or auto switch may be damaged.

On the other hand, tightening below the range of tightening torque may allow the auto switch to slip out of position.

3. Do not carry a cylinder by the auto switch lead wires.

Never carry a cylinder by its lead wires. This may not only cause broken lead wires, but it may cause internal elements of the auto switch to be damaged by the stress.

4. Fix the auto switch with appropriate screw installed on the switch body. If using other screws, auto switch may be damaged.

5. Mount an auto switch at the center of the operating range. In the case of 2-color display auto switch, mount it at the center of the green LED illuminating range.

Adjust the mounting position of the auto switch so that the piston stops at the center of the operating range. (The mounting position shown in the catalog indicates the optimum position at stroke end.)

If mounted at the end of the operating range (around the borderline of ON and OFF), operation will be unstable depending on the operating environment. Also there are some cylinders or actuators with individual setting methods for auto switches. If so, mount it in accordance with the indicated method.

Even if 2-color indication solid state auto switches are fixed at a proper operating range (the green light lights up), the operation may become unstable depending on the installation environment or magnetic field disturbance.

(Magnetic body, external magnetic field, proximal installation of cylinders with built-in magnet and actuators, temperature change, other factors for magnetic force fluctuation during operation, etc.)

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Related
Equipment

D-□



Auto Switches Precautions 4

Be sure to read this before handling.

Wiring

⚠ Caution

1. Confirm proper insulation of wiring.

Be certain that there is no faulty wiring insulation (contact with other circuits, ground fault, improper insulation between terminals, etc.). Damage may occur due to excess current flow into a switch.

2. Do not wire with power lines or high voltage lines.

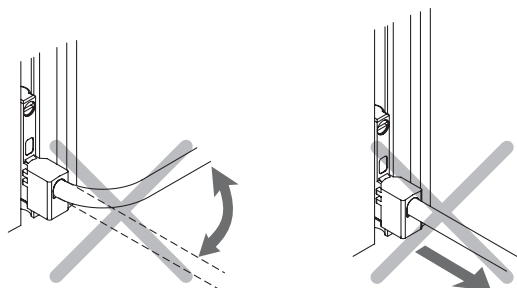
Wire separately from power lines or high voltage lines, avoiding parallel wiring or wiring in the same conduit with these lines. Control circuits containing auto switches may malfunction due to noise from these other lines.

3. Avoid repeatedly bending or stretching lead wires.

Broken lead wires will result from repeatedly applying bending stress or stretching force to the lead wires.

Stress and tensile force applied to the connection between the lead wire and auto switch increases the possibility of disconnection.

Keep the lead wire from moving especially in the area where it connects with the auto switch.



4. Be certain to connect the load before power is applied.

<2-wire type>

If the power is turned ON when an auto switch is not connected to a load, the auto switch will be instantly damaged because of excess current (short circuit).

It is the same as when the 2-wire brown lead wire (+, output) is directly connected to the (+) power supply terminal.

5. Do not allow short-circuit of loads.

<Reed>

If the power is turned ON with a load in a short circuited condition, the auto switch will be instantly damaged because of excess current flow into the switch.

<Solid state>

All models of D-J51, G5NB and PNP output type auto switches do not have built-in short circuit protection circuits.

If a load is short circuited, the auto switch will be instantly damaged as in the case of reed auto switches.

Take special care to avoid reverse wiring with the brown power supply line and the black output line on 3-wire type auto switches.

6. Avoid incorrect wiring.

<Reed>

A 24 VDC auto switch with indicator light has polarity. The brown lead wire or terminal No. 1 is (+), and the blue lead wire or terminal No. 2 is (–).

[For D-97, (+) is on the no-displayed side, (–) is on the black line side.]

1) If connections are reversed, an auto switch will operate, however, the light emitting diode will not light up.

Also, take note that a current greater than that specified will damage a light emitting diode and it will no longer operate.

Applicable model:

D-A73, A73H, A73C, C73, C73C, E73A, Z73

D-R73, R73C, 97, 93A, A93, A93V

D-A33, A34, A33A, A34A, A44, A44A

D-A53, A54, B53, B54

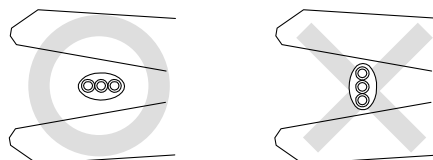
2) When using a 2-color indicator type auto switch (D-A79W, A59W and B59W), the auto switch will constantly remain ON if the connections are reversed.

<Solid state>

1) If connections are reversed on a 2-wire type auto switch, the auto switch will not be damaged if protected by a protection circuit, but the auto switch will always stay in an ON state. However, it is still necessary to avoid reversed connections, since the auto switch could be damaged by a load short circuit in this condition.

2) If connections are reversed (power supply line + and power supply line –) on a 3-wire type auto switch, the auto switch will be protected by a protection circuit. However, if the power supply line (+) is connected to the blue wire and the power supply line (–) is connected to the black wire, the auto switch will be damaged.

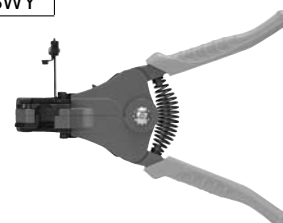
7. When the lead wire sheath is stripped, confirm the stripping direction. The insulator may be split or damaged depending on the direction. (D-M9□ only)



Recommended Tool

Description	Model
Wire stripper	D-M9N-SWY

* Stripper for a round cable (ø2.0) can be used for a 2-wire type cable.





Auto Switches Precautions 5

Be sure to read before handling.

Operating Environment

Warning

1. Never use in an atmosphere of explosive gases.

The structure of auto switches is not intended to prevent explosion. Never use in an atmosphere with an explosive gas since this may cause a serious explosion.

Please contact SMC concerning ATEX compliant products.

Caution

1. Do not use in an area where a magnetic field is generated.

Auto switches will malfunction or magnets inside cylinders/actuators will become demagnetized. (Please consult with SMC if a magnetic field resistant auto switch can be used.)

2. Do not use in an environment where the auto switch will be continually exposed to water.

Although auto switches satisfy IEC standard IP67 construction except some models (D-A3□, A44□, G39, K39□, RNK, RPK) do not use auto switches in applications where continually exposed to water splash or spray. Poor insulation or swelling of the potting resin inside auto switches may cause malfunction.

3. Do not use in an environment with oil or chemicals.

Please consult with SMC if auto switches will be used in an environment with coolant, cleaning solvent, various oils or chemicals. If auto switches are used under these conditions for even a short time, they may be adversely affected by improper insulation, malfunction due to swelling of the potting resin, or hardening of the lead wires.

4. Do not use in an environment with temperature cycles.

Please consult with SMC if auto switches are used where there are temperature cycles other than normal temperature changes, as there may be adverse effects inside the auto switches.

Caution

5. Do not use in an environment where there is excessive impact shock.

<Reed>

When excessive impact (300 m/s² or more) is applied to a reed auto switch during operation, the contact point will malfunction and generate or cut off a signal momentarily (1 ms or less). Please consult with SMC if a solid state auto switch can be used according to the environment.

6. Do not use in an area where surges are generated.

<Solid state>

When there are units (solenoid type lifter, high frequency induction furnace, motor, radio equipment etc.) which generate a large amount of surge in the area around cylinders/actuators with solid state auto switches, this may cause deterioration or damage to the auto switch's internal circuit elements. Avoid sources of surge generation and disorganized lines.

7. Avoid accumulation of iron waste or close contact with magnetic substances.

When a large amount of iron waste such as machining chips or spatter is accumulated, or a magnetic substance (something attracted by a magnet) is brought into close proximity with a cylinder with auto switches, or an actuator, it may cause the auto switch to malfunction due to a loss of the magnetic force inside the cylinder/actuator.

8. Please contact SMC concerning water resistance, elasticity of lead wires, usage at welding sites, etc.

9. Do not use in direct sunlight.

10. Do not mount the product in locations where it is exposed to radiant heat.

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Related
Equipment

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Auto Switches Precautions 6

Be sure to read before handling.

Maintenance

Warning

1. Removal of equipment, and supply/exhaust of compressed air

Before any machinery or equipment is removed, first ensure that the appropriate measures are in place to prevent the fall or erratic movement of driven objects and equipment, then cut off the electric power and reduce the pressure in the system to zero. Only then should you proceed with the removal of any machinery and equipment.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent actuators from moving suddenly.

Caution

1. Perform the following maintenance periodically in order to prevent possible danger due to unexpected auto switch malfunction.

- 1) Secure and tighten auto switch mounting screws.

If screws become loose or the mounting position is dislocated, retighten them after readjusting the mounting position.

- 2) Confirm that there is no damage to lead wires.

To prevent faulty insulation, replace auto switches or repair lead wires, etc., if damage is discovered.

- 3) Confirm the display of the green light on the 2-color display auto switch.

Confirm that the piston stops at the center of the operating range (the green LED is on). If the red LED is on, the mounting position is not appropriate.

Readjust to the center of the operating range. Also there are some cylinders or actuators with individual setting methods for auto switches. If so, mount it in accordance with the indicated method.